Application of the Delta Smelt MAST

Delta Stewardship Council- January 29 2015

Interagency Ecological Program
Cooperative Ecological Investigations Since 1970

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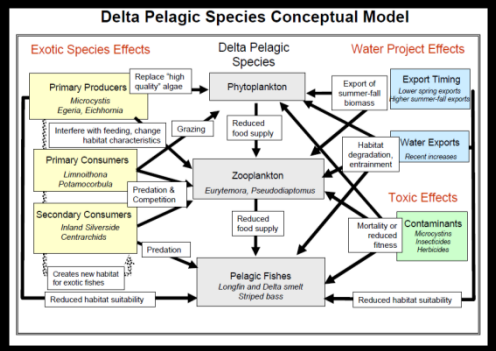
California Department of Water Resources

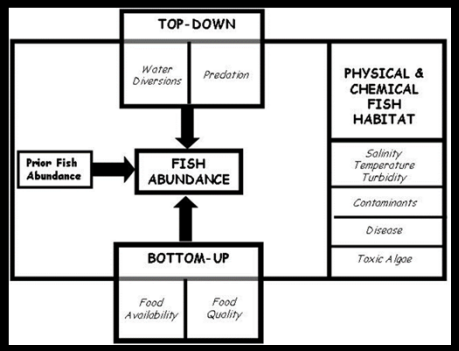
What is a Conceptual Model?

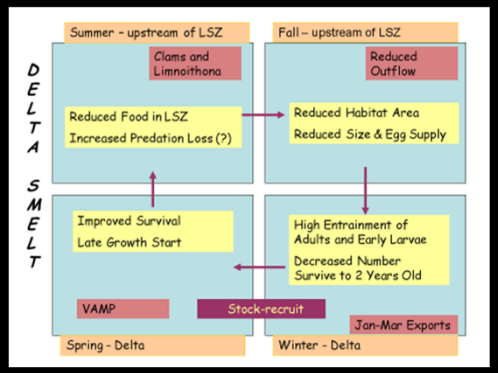
Conceptual models are formalized versions of mental models that are communicated to others verbally and graphically.

Evolving IEP Conceptual Models in the Last Decade:

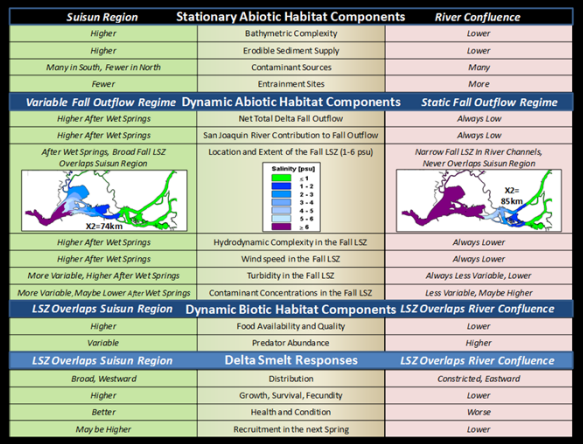


Pelagic organism decline 2005



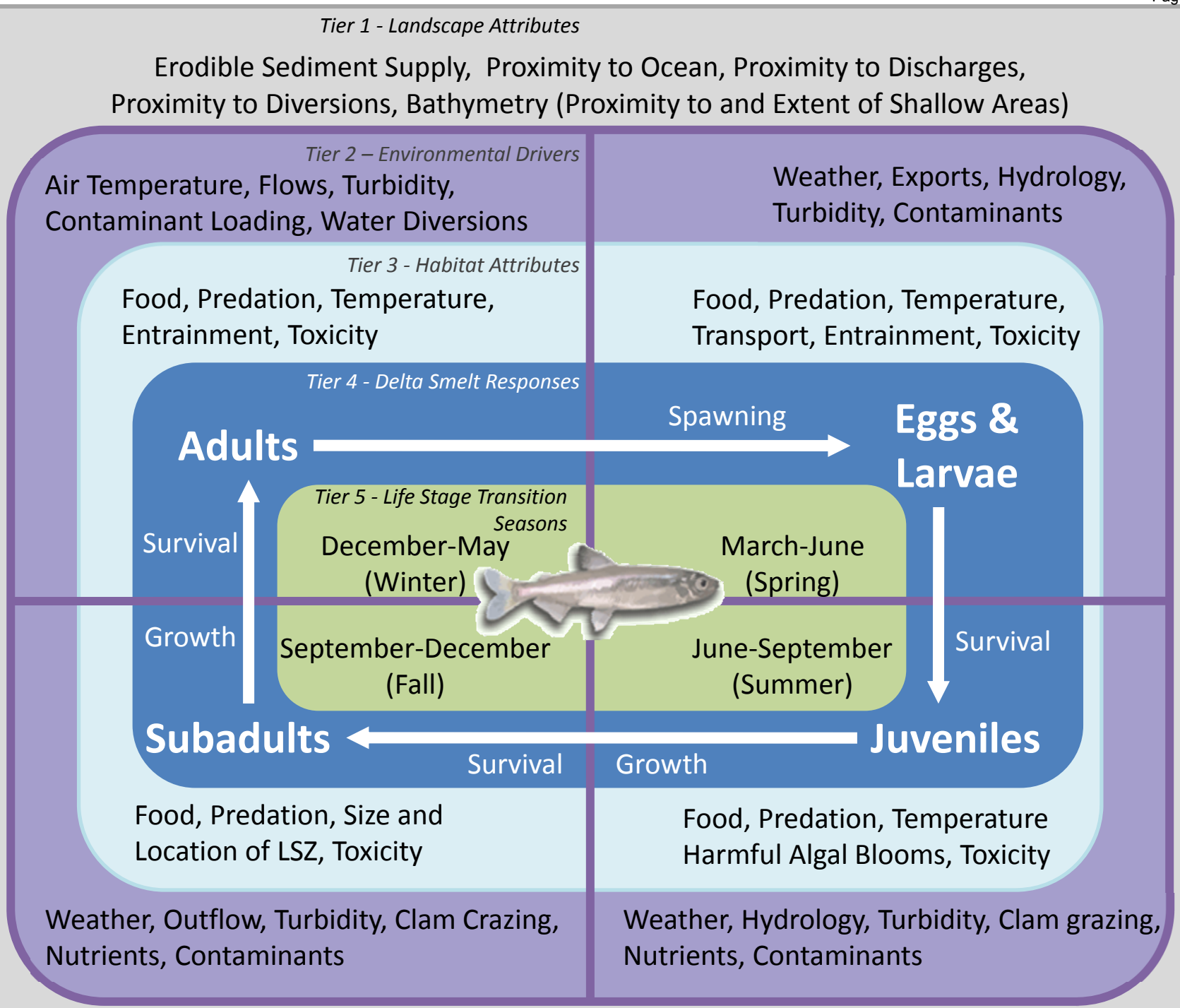


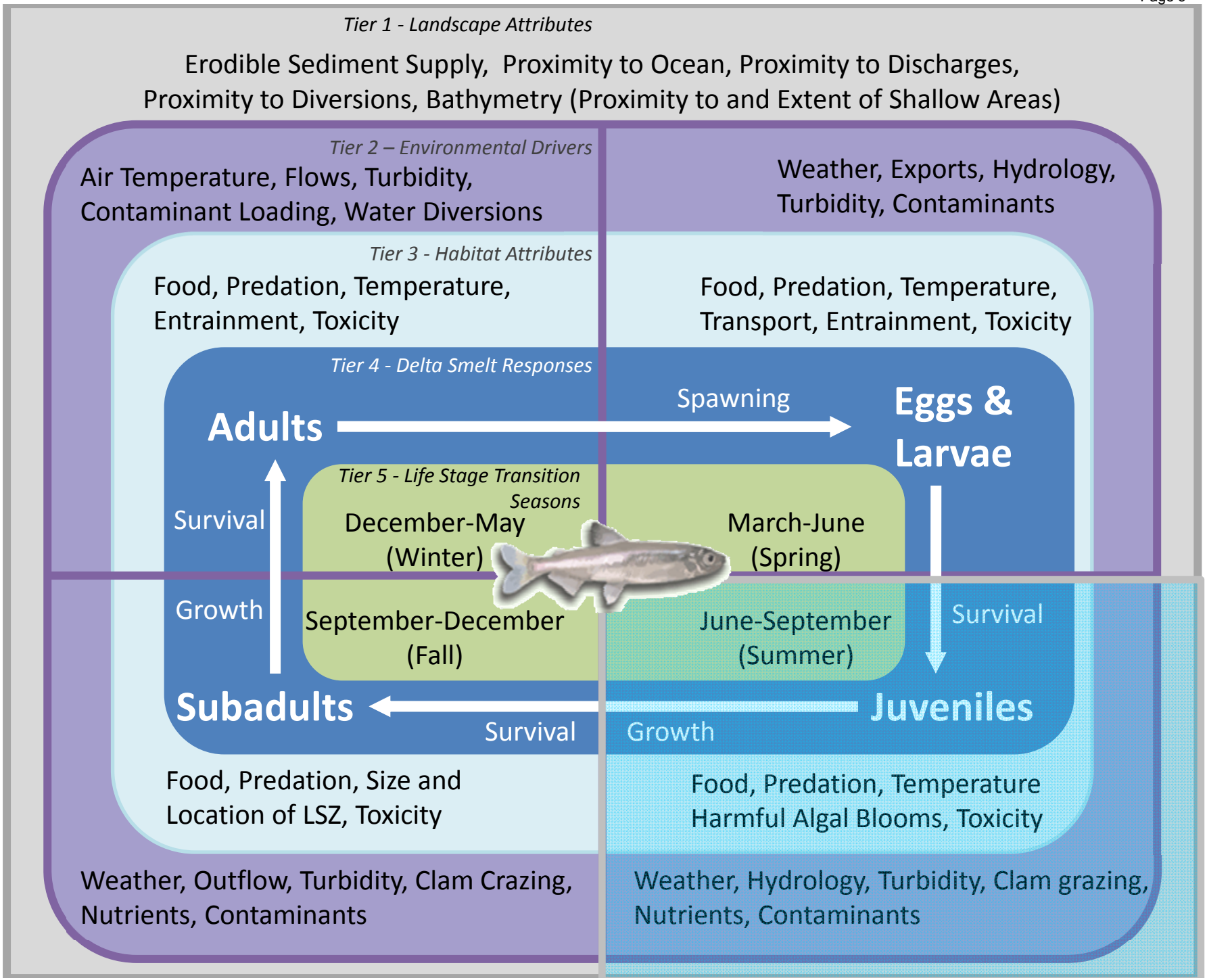
Pelagic organism decline 2008, 2010



Suisun Region	Stationary Abiotic Habitat Components	River Confluence
Higher	Bathymetric Complexity	Lower
Higher	Erodible Sediment Supply	Lower
Many in South, Fewer in North	Contaminant Sources	Many
Fewer	Entrainment Sites	More
Variable Fall Outflow Regime	**Dynamic Abiotic Habitat Components**	**Static Fall Outflow Regime**
Higher After Wet Springs	Net Total Delta Fall Outflow	Always Low
Higher After Wet Springs	San Joaquin River Contribution to Fall Outflow	Always Low
After Wet Springs, Broad Fall LSZ Overlaps Suisun Region	Location and Extent of the Fall LSZ (1-6 psu)	Narrow Fall LSZ in River Channels, Never Overlaps Suisun Region
Higher After Wet Springs	Hydrodynamic Complexity in the Fall LSZ	Always Lower
Higher After Wet Springs	Wind speed in the Fall LSZ	Always Lower
More Variable, Higher After Wet Springs	Turbidity in the Fall LSZ	Always Less Variable, Lower
More Variable, Maybe Lower After Wet Springs	Contaminant Concentrations in the Fall LSZ	Less Variable, Maybe Higher
LSZ Overlaps Suisun Region	**Dynamic Biotic Habitat Components**	**LSZ Overlaps River Confluence**
Higher	Food Availability and Quality	Lower
Variable	Predator Abundance	Higher
LSZ Overlaps Suisun Region	**Delta Smelt Responses**	**LSZ Overlaps River Confluence**
Broad, Westward	Distribution	Constricted, Eastward
Higher	Growth, Survival, Fecundity	Lower
Better	Health and Condition	Worse
May be Higher	Recruitment in the next Spring	Lower

Delta smelt fall low salinity habitat 2014


Tier 1 - Landscape Attributes
Erodible Sediment Supply, Proximity to Ocean, Proximity to Discharges, Proximity to Diversions, Bathymetry (Proximity to and Extent of Shallow Areas)
Tier 2 – Environmental Drivers
Air Temperature, Flows, Turbidity, Contaminant Loading, Water Diversions
Weather, Exports, Hydrology, Turbidity, Contaminants
Tier 3 - Habitat Attributes
Food, Predation, Temperature, Entrainment, Toxicity
Food, Predation, Temperature, Transport, Entrainment, Toxicity
Tier 4 - Delta Smelt Responses
Adults
Spawning
Eggs & Larvae
Tier 5 - Life Stage Transition Seasons
Survival
December-May (Winter)
March-June (Spring)
Growth
September-December (Fall)
June-September (Summer)
Survival
Subadults
Juveniles
Survival
Growth
Food, Predation, Size and Location of LSZ, Toxicity
Food, Predation, Temperature Harmful Algal Blooms, Toxicity
Weather, Outflow, Turbidity, Clam Crazing, Nutrients, Contaminants
Weather, Hydrology, Turbidity, Clam grazing, Nutrients, Contaminants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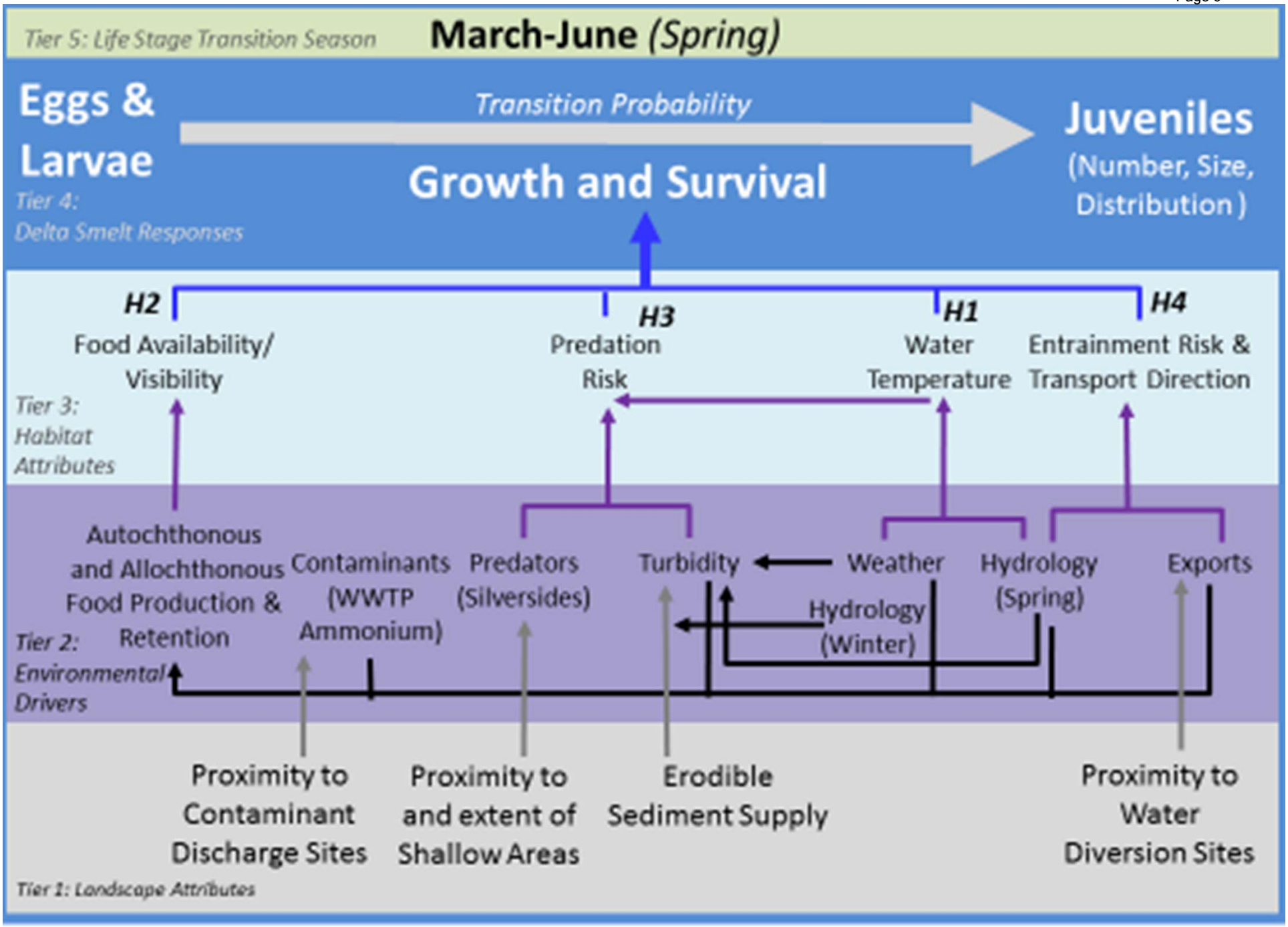
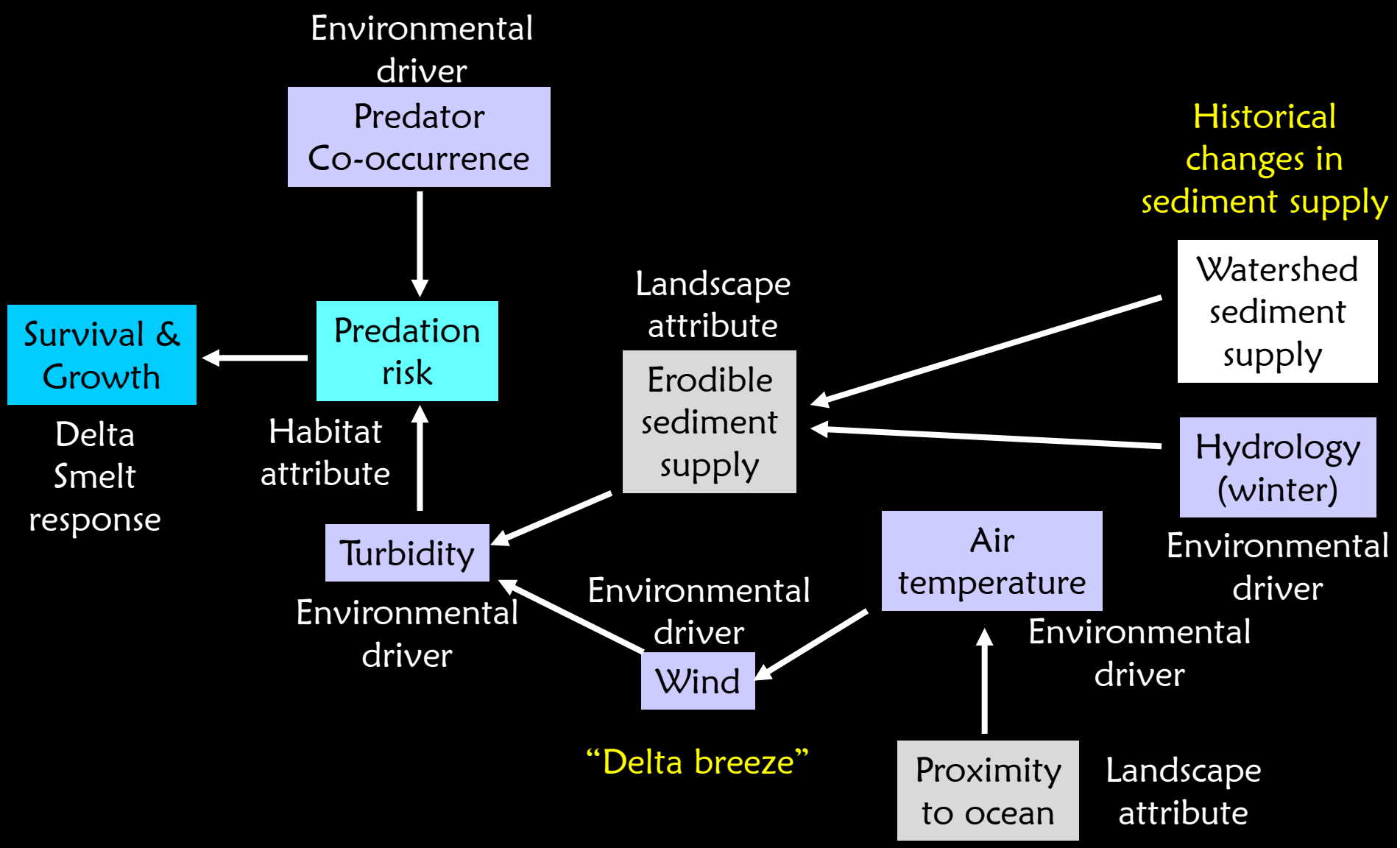

Tier 5: Life Stage Transition Season
March-June (Spring)
Eggs & Larvae
Tier 4: Delta Smelt Responses
Transition Probability
Growth and Survival
Juveniles
(Number, Size, Distribution)
H2
Food Availability/ Visibility
H3
Predation Risk
H1
Water Temperature
H4
Entrainment Risk & Transport Direction
Tier 3: Habitat Attributes
Autochthonous and Allochthonous Food Production & Retention
Contaminants (WWTP Ammonium)
Predators (Silversides)
Turbidity
Weather
Hydrology (Winter)
Hydrology (Spring)
Exports
Tier 2: Environmental Drivers
Proximity to Contaminant Discharge Sites
Proximity to and extent of Shallow Areas
Erodible Sediment Supply
Proximity to Water Diversion Sites
Tier 1: Landscape Attributes

Linkages: Juveniles/subadults & turbidity



Take Home Messages

- "It takes a year to make a smelt"
- Model used to evaluate hypotheses
  - Why did Delta Smelt abundance increase in the wet year 2011, but not in the wet year 2006?
    - Larval production similar in both wet years.
    - Prolonged cool water temperatures likely contributed to better juvenile survival in 2011.
  - Implications
    - High winter-spring flows "set the stage" for a strong year class
    - But: good water temperatures and food needed later to sustain higher abundance

Recommended Applications of Delta Smelt MAST Conceptual Model

- Address scientific questions important to management .
- Identification of science priorities & gaps.
- Guidance for adaptive management.
- Development of quantitative models.

MAST Drought Synthesis

- Builds on Delta Smelt MAST.
- Focus on analysis of ongoing monitoring.
  - Additional work on aquatic weeds, Delta Smelt, and *Microcystis (DFW funds)*.
  - Short 2014 resident fishes survey (FWS).
- Questions:
  - Changes since previous decade?
  - Differences from last drought?
  - Ecosystem changes?

MAST Drought Predictions

Conceptual Model Tier & Variable
Delta Smelt Responses (selected from 7)
Abundance
Distribution
Growth
Habitat Attributes (selected from 9)
Harmful Algal Blooms
Predation Risk
Water Temperature
Environmental Drivers (selected from 12)
Mississippi Silverside Abundance
Largemouth Bass Abundance
Water Clarity
Air Temperature
Landscape Attributes (selected from 6)
Proximity to and Extent of Shallow Areas
Erodible Sediment Supply
Proximity to Ocean

Summary of Variables Likely Affected By Drought

MAST Drought Predictions

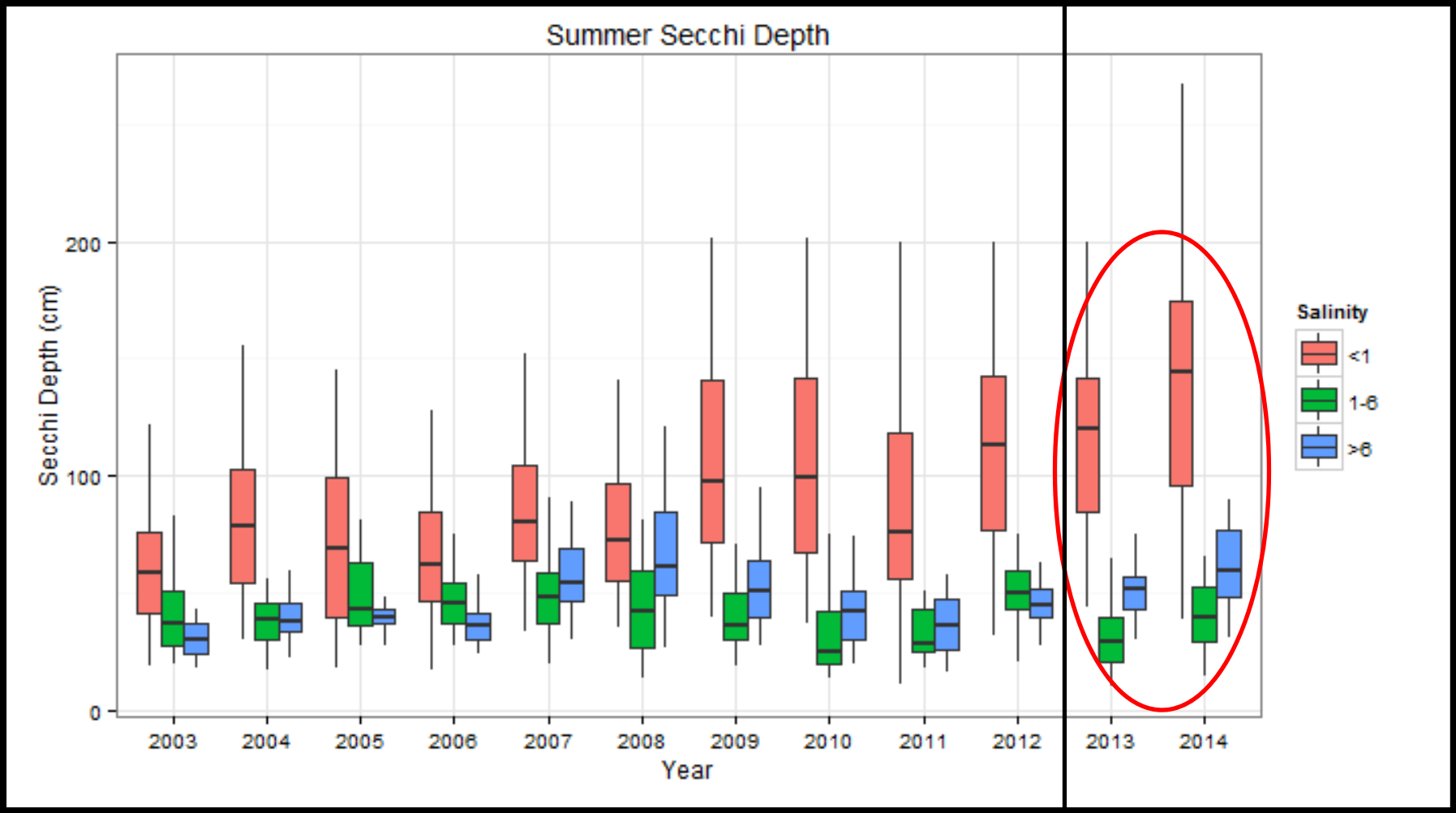
Conceptual Model Tier & Variable	Adults (Dec – May)	Larvae (Mar – Jun)	Juveniles (Jun – Sep)	Subadults (Sep – Dec)
Delta Smelt Responses (selected from 7)				
Abundance				
Distribution				
Growth				
Habitat Attributes (selected from 9)				
Harmful Algal Blooms				
Predation Risk				
Water Temperature				
Environmental Drivers (selected from 12)				
Mississippi Silverside Abundance				
Largemouth Bass Abundance				
Water Clarity				
Air Temperature				
Landscape Attributes (selected from 6)				
Proximity to and Extent of Shallow Areas				
Erodible Sediment Supply				
Proximity to Ocean				

MAST Drought Predictions

Conceptual Model Tier & Variable	Adults (Dec – May)	Larvae (Mar – Jun)	Juveniles (Jun – Sep)	Subadults (Sep – Dec)
Delta Smelt Responses (selected from 7)				
Abundance	↓	↓	↓	↓
Distribution	↓	↓	↓	↓
Growth	↓	↓	↓	↓
Habitat Attributes (selected from 9)				
Harmful Algal Blooms		↑	↑	↑
Predation Risk	↑	↑	↑	↑
Water Temperature	↓ or ↑	↑	↑	↑
Environmental Drivers (selected from 12)				
Mississippi Silverside Abundance		↔		
Largemouth Bass Abundance	↔		↓	↓
Water Clarity	↑	↑	↑	↑
Air Temperature	↓ or ↑	↑	↑	↑
Landscape Attributes (selected from 6)				
Proximity to and Extent of Shallow Areas	↓	↓	↓	↓
Erodible Sediment Supply	↓	↓	↓	↓
Proximity to Ocean	↓	↓	↓	↓

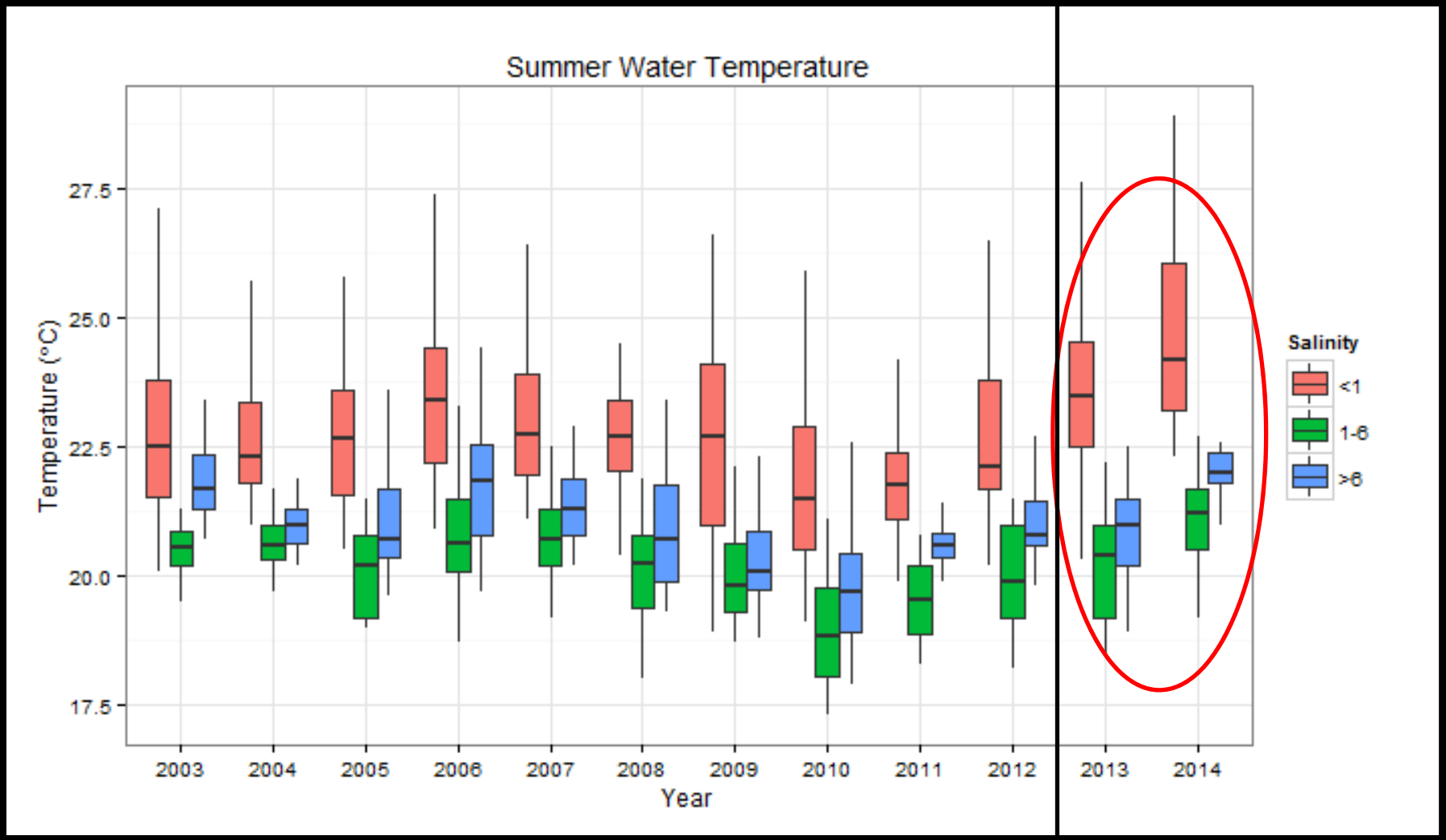
Some Preliminary Drought MAST Results

Increasing Water Clarity



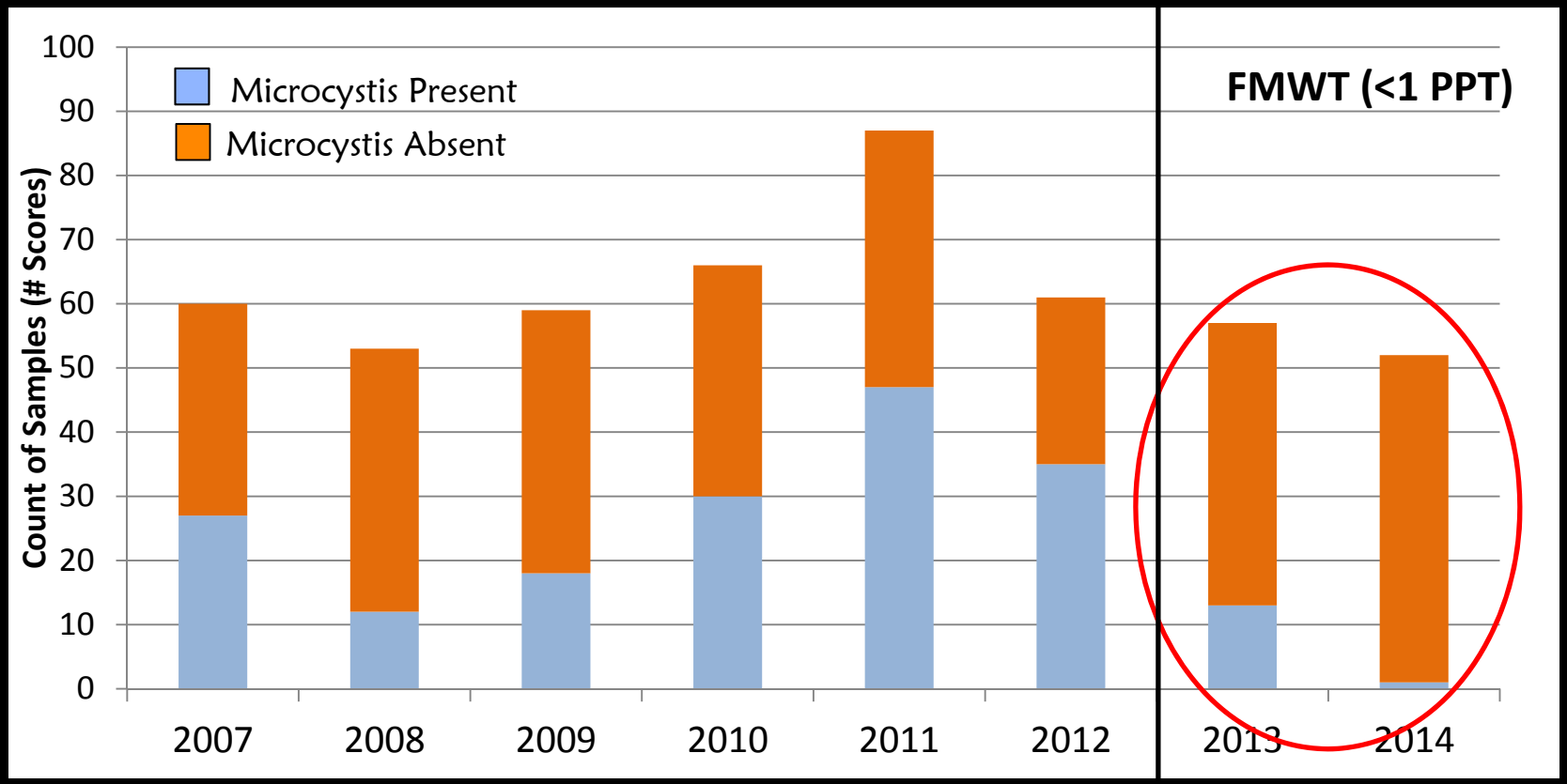
Some Preliminary Drought MAST Results

Increasing Water Temperature

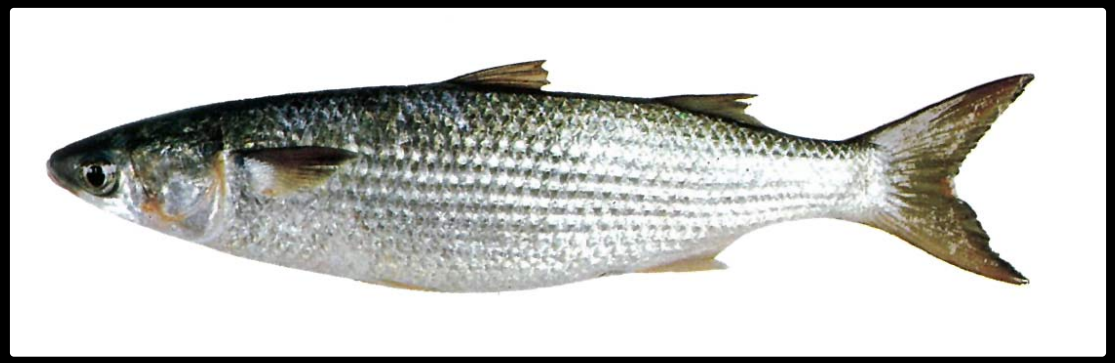


Some Preliminary Drought MAST Results

More Prevalent Harmful Algal Blooms



Increasing Invasion Rate?

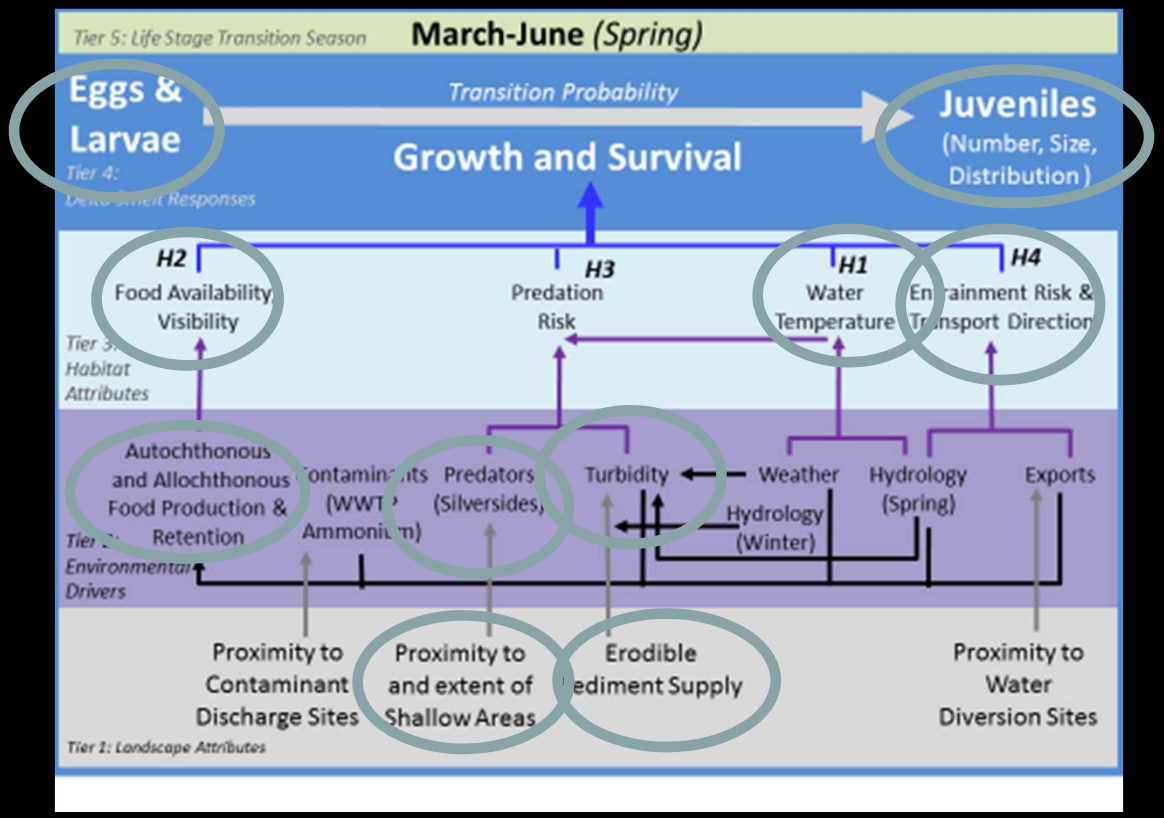


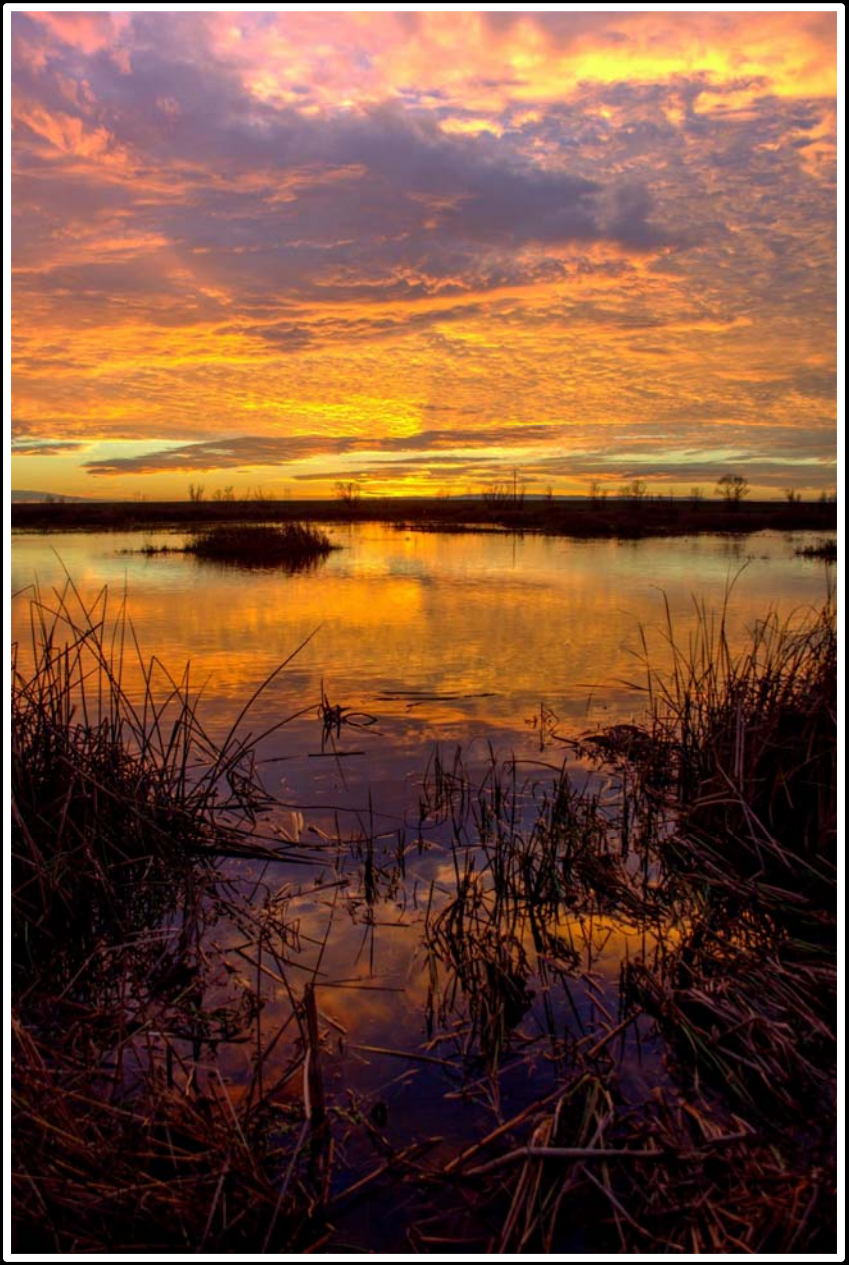
Mullet
Mugil cephalus

Weather Loach
Misgurnus anquillicaudatus

Other Applications of Delta Smelt MAST

- Collaborative Adaptive Management Team.
- IEP Tidal Wetlands Monitoring Team.





Questions?